

JEE ADVANCED - 2 | PAPER - 1

JEE 2022

Date 28th March, 2021	Maximum Marks 198	Duration 3 Hours
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General Instructions

- The question paper consists of 3 Subject (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each Part has **three** sections (Section 1, Section 2 & Section 3).
- Section 1** contains **6 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

Section 2 contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

Section 3 contains **6 Numerical Value Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25, 0.08)
- For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code**, **Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Name of the Candidate (In CAPITALS) :

Roll Number :

OMR Bar Code Number :

Candidate's Signature : Invigilator's Signature

MARKING SCHEME

SECTION - 1 (Maximum Marks: 18)

- This section contains **SIX (06)** Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +3 If only (all) the correct option(s) is(are) chosen
Zero Mark: 0 if none of the options is chosen (i.e. the question is unanswered)
Negative Marks: -1 In all other cases.

SECTION - 2 (Maximum Marks: 24)

- This section consists of **SIX (06)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If only (all) the correct option(s) is(are) chosen
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen and both of which are correct
Partial Marks: +1 If two or more options are correct but **ONLY** one option is chosen, and it is a correct option
Zero Mark: 0 if none of the options is chosen (i.e. the question is unanswered)
Negative Marks: -2 In all other cases.

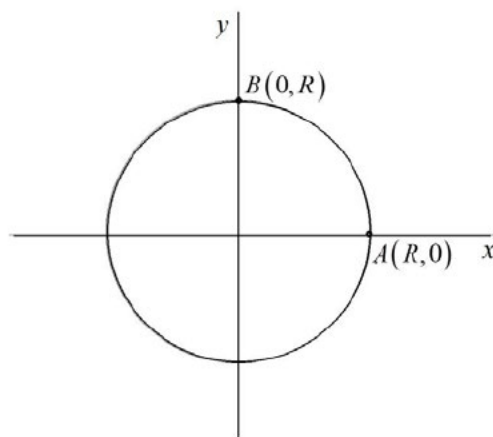
SECTION – 3 (Maximum Marks: 24)

- This section contains **6 Numerical Value Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25, 0.08)
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If **ONLY** the correct Integer value is entered. There is **NO negative marking**.
Zero Marks: 0 In all other cases.

SECTION 1
SINGLE CORRECT ANSWERS TYPE

This section contains 06 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

1. Two particles, A and B , are initially at rest at the points $(R, 0)$ and $(0, R)$. Starting at $t = 0$, the particles move anti-clockwise along the circular path of radius R centred at the origin shown in the figure, with constant speed v and $\frac{3v}{2}$. The time instant when the particles meet for the first time is:

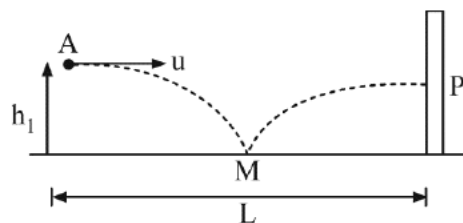


- (A) $t = \frac{\pi R}{v}$ (B) $t = \frac{3\pi R}{2v}$
(C) $t = \frac{2\pi R}{v}$ (D) $t = \frac{3\pi R}{v}$
2. A sonometer wire of length L and mass m is clamped at both its ends as well as a point at a distance $\frac{L}{3}$ from one of its ends. If the minimum frequency at which both segments of the wire can resonate together is f , the tension in the wire is given by:

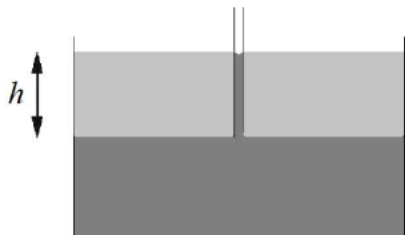
- (A) $\frac{4mL}{9f^2}$ (B) $\frac{16mL}{9f^2}$ (C) $\frac{16mLf^2}{9}$ (D) $\frac{4mLf^2}{9}$
3. The potential energy of a particle of mass 0.08 kg moving on the X -axis is given as a function of its position x as: $U(x) = x^2 + 8x - 2$. Then, which of the following can represent the position of the particle as a function of time?

- (A) $x(t) = -4 + 4 \sin\left(5t + \frac{\pi}{3}\right)$ (B) $x(t) = -4 + 2 \cos(t)$
(C) $x(t) = 2 + 2 \cos\left(5t - \frac{\pi}{6}\right)$ (D) $x(t) = 2 + 4 \sin\left(t - \frac{\pi}{4}\right)$
4. A girl throws a ball horizontally with velocity u from a height h_1 directly towards a vertical wall at a distance L . After colliding with the ground once, the ball hits the wall horizontally at a point P as shown. The height of the point P above the ground is given by:

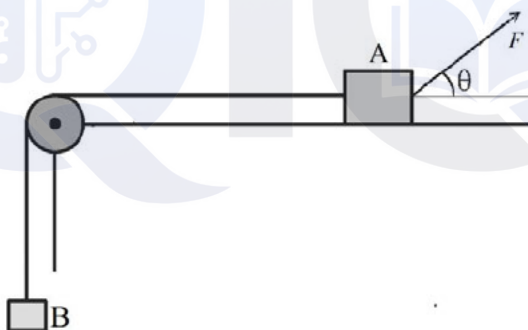
- (A) $\sqrt{\frac{2}{gh_1}}uL$ (B) $\left(\frac{L}{u}\sqrt{\frac{g}{2}} - \sqrt{h_1}\right)^2$
(C) $\frac{gL^2}{2u^2} - h_1$ (D) $h_1\left(1 - \frac{gL}{2u^2}\right)$



5. A glass capillary of a small radius r is dipped vertically into a liquid of density ρ_1 and surface tension σ . The angle of contact is θ . Now, with the capillary held in place, another liquid, of density $\rho_2 (< \rho_1)$ and immiscible with the liquid already in the container, is poured very gently into the vessel. It is found that when a column h of the second liquid has been poured, the level of liquid inside the capillary is the same the level of liquid outside it. Which of these options is correct? (g is the acceleration due to gravity)



- (A) $h = \frac{2\sigma \cos \theta}{(2\rho_1 - \rho_2)rg}$ (B) $h = \frac{2\sigma \cos \theta}{(\rho_1 - \rho_2)rg}$
- (C) $h = \frac{2\sigma \cos \theta}{rg} \left(\frac{1}{2\rho_2} - \frac{1}{\rho_1} \right)$ (D) $h = \frac{2\sigma \cos \theta}{rg} \left(\frac{1}{\rho_2} - \frac{1}{\rho_1} \right)$
6. Two blocks A and B of mass 6 kg and 1 kg respectively are arranged as shown with a massless string and ideal pulley. The block A rests on a rough horizontal table with coefficient of friction 0.1 . A force of magnitude F is applied on A in a direction making an angle $\theta = \sin^{-1}(0.6)$ with the horizontal as shown. The range of values of F for which the blocks remain in equilibrium is: ($g = 10 \text{ m/s}^2$)



- (A) $3.92 \text{ N} \leq F \leq 21.18 \text{ N}$ (B) $5.41 \text{ N} \leq F \leq 21.18 \text{ N}$
- (C) $3.92 \text{ N} \leq F \leq 18.61 \text{ N}$ (D) $5.41 \text{ N} \leq F \leq 18.61 \text{ N}$

SPACE FOR ROUGH WORK

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of 06 Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

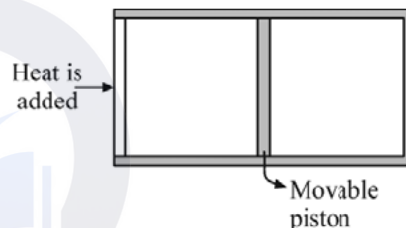
7. The melting point of a substance X is 25°C . Liquid X at 40°C is slowly added to 20 g of solid X at 20°C kept in an insulated container. It is found that solid X begins to melt after the addition of 8 g of liquid X , and the solid X has melted completely after the addition of 88 g of liquid X . If C_S and C_L denote the specific heat of solid and liquid X respectively, and the latent heat of fusion of solid X is 150 kJ/kg , which of these options is/are correct?

- (A) $C_S = 3.0 \text{ kJ/kg}^{\circ}\text{C}$ (B) $C_L = 2.5 \text{ kJ/kg}^{\circ}\text{C}$
(C) $C_S = 3.6 \text{ kJ/kg}^{\circ}\text{C}$ (D) $C_L = 3.0 \text{ kJ/kg}^{\circ}\text{C}$

8. A rigid vessel is divided into two compartments by an insulating piston that can slide without friction. All walls of the vessel are insulating except the left wall of the left compartment. Initially, both compartments contain 2000 cm^3 of the same monoatomic gas at temperature 300 K and pressure 10^5 N/m^2 . Now, an amount of heat ΔQ is added slowly to the vessel through the left wall such that the volume of the right compartment reduces to 1800 cm^3 . Which of these options is/are correct?

[Given: $(0.9)^{-5/3} = 1.2$]

- (A) The final pressure in the left compartment is $1.2 \times 10^5 \text{ N/m}^2$
(B) The final temperature in the right compartment is 324 K
(C) $\Delta Q = 120 \text{ J}$
(D) $\Delta Q = 96 \text{ J}$



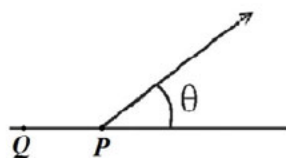
9. A train appears to move at velocity $12\sqrt{2} \text{ m/s}$ towards North-West to a cyclist moving at a velocity 4 m/s towards North. Assuming that the speed of the cyclist and the actual velocity of the train (both magnitude and direction) remain unchanged throughout, which of these options is/are correct?

- (A) The train's actual velocity is 20 m/s in a direction $\tan^{-1}\left(\frac{3}{4}\right)$ West of North
(B) If the cyclist moves towards East, the train still appears to move towards North-West to him
(C) If the cyclist moves towards East, the train appears to move at velocity $16\sqrt{2} \text{ m/s}$ to him
(D) The velocity of the train as seen by the cyclist is maximum if he moves opposite to the direction of the train's actual velocity

10. In a resonance column experiment, a vertically fixed cylindrical tube is completely filled with water. Then, the water level is lowered slowly and the air column above the water is repeatedly tested with a tuning fork for resonance. The tube diameter is 5 cm and the tube length is 1.2 m . When a tuning fork of frequency 420 Hz is used, the first resonance is heard for a water column of height 101.5 cm . Which of these options is/are correct?

- (A) The speed of sound in air derived from this experiment is 340 m/s
(B) The second resonance with the same tuning fork will be heard for a water column of height 61.5 cm
(C) A total of 4 resonances will be heard with this tuning fork
(D) If the experiment is repeated with a tuning fork of frequency 480 Hz , the first resonance is heard for a water column of height 104 cm

11. A cylindrical bucket of height H has a small hole (of area of cross-section A) in its side near its bottom. The bucket is initially empty. Now a tap delivering water at a constant volumetric rate Q into the bucket is opened. Which of these options is/are correct? (g is the acceleration due to gravity)
- (A) If $Q > (\sqrt{2gH})A$, the level of water keeps rising in the bucket until it overflows
- (B) If $Q < (\sqrt{2gH})A$, the level of water rises in the bucket for some time, then becomes constant
- (C) The volume of water leaving the hole per unit time remains constant
- (D) The volume of water leaving the hole per unit time increases for some time and then becomes constant
12. A particle is projected from a point P on the ground at an angle θ with the horizontal. Let Q be a general point on the ground behind P . During the flight of the particle:



- (A) Its angular momentum about P keeps increasing
- (B) Its angular momentum about P first decreases and then increases
- (C) Its angular momentum about Q keeps increasing
- (D) Its angular momentum about Q first decreases and then increases

SPACE FOR ROUGH WORK

SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

This section has 06 Questions. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to **TWO** decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25)

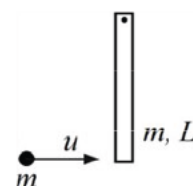
13. A spherical black body of total surface area 200 cm^2 is heated to temperature 400 K and placed in a room at temperature 300 K . The net rate at which the black body loses heat to the surroundings initially is _____ W.

[Assume that radiation is the only mode of heat transfer, Stefan-Boltzmann constant

$$\sigma = \frac{40}{7} \times 10^{-7} \text{ W/m}^2 \text{K}^4]$$

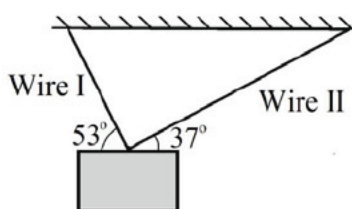
14. A rod of mass m and length L is pivoted at one of its ends such that it hangs in equilibrium. A particle, also of mass m moving with velocity u hits the rod horizontally at its lower end. The collision is elastic. Immediately after the collision, the velocity of the centre of the rod is v_C .

The value of $\frac{v_C}{u}$ is _____.



15. Two wires, I and II, are used to hang a load such that both wires are in the same vertical plane. The diameters of the wires are in the ratio 2:3, and their Young's moduli are in the ratio 8:1. Assuming that the extensions produced in the wires are very small, the ratio of the extensions, $\frac{\Delta l_1}{\Delta l_2}$ is equal to _____.

$$(\cos 53^\circ = 0.6, \cos 37^\circ = 0.8)$$



16. Two particles A and B of mass m and $4m$, initially at a distance a from each other, are released from rest. The particles move towards each other due to their mutual gravitational attraction. Neglect the forces on the particles due to all other bodies. At the instant the distance between the particles is $\frac{a}{2}$,

the velocity of A is $\left(X \left(\frac{Gm}{a} \right) \right)^{1/2}$. The value of X is _____.

(G denotes the gravitational constant)

17. A spherical steel ball of mass 40 g and density $8 \times 10^3 \text{ kg/m}^3$ is dropped into a column of a liquid of density $2 \times 10^3 \text{ kg/m}^3$. At the instant when the velocity of the ball is half of its terminal velocity, the force of viscosity acting on the ball is _____ N. ($g = 10 \text{ m/s}^2$)
18. An artillery gun of mass M (with the shell loaded) and negligible height, resting on a frictionless surface of ice and free to move, fires a shell of mass $\frac{M}{25}$ at an angle 45° with the horizontal. The shell lands on the ground after time T . At the instant of the shell's landing, the distance between the gun and the shell is $X(gT^2)$: (g is the acceleration due to gravity). The value of X is _____.

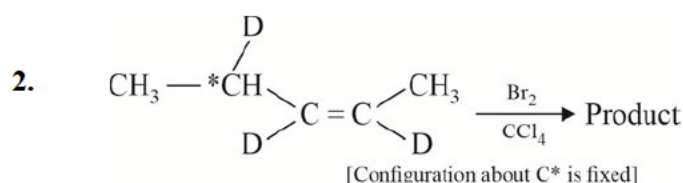
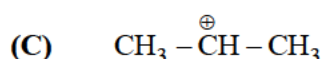
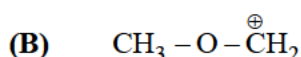
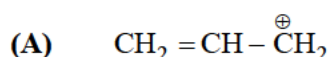
SPACE FOR ROUGH WORK



SECTION 1
SINGLE CORRECT ANSWERS TYPE

This section contains 06 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

1. Which one of the following carbocations is most stable ?



Product of the above reaction will be :

(A) Racemic mixture

(B) Meso compound

(C) Structural isomers

(D) Diastereomers

3. The Schrodinger wave equation for hydrogen atom is :

$$\psi_{2s} = \frac{1}{4\sqrt{2}\pi} \left(\frac{1}{a_0} \right)^{3/2} \left(2 - \frac{r}{a_0} \right) e^{-r/2a_0}$$

Where a_0 is bohr radius. If the radial node in 2s be at r_0 then r_0 would be equal to: [Given $a_0 = 0.53 \text{ \AA}$]

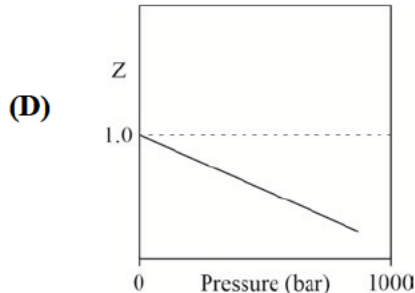
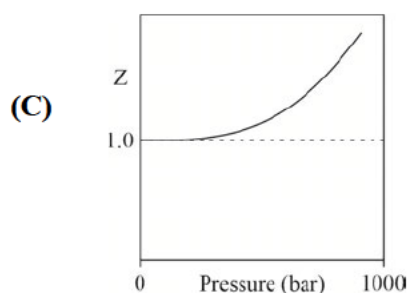
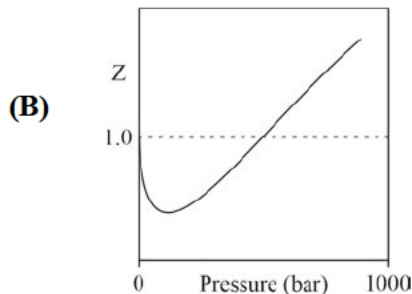
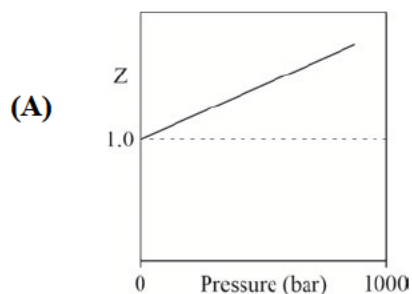
(A) $0.265 \text{ \AA}$

(B) $0.75 \text{ \AA}$

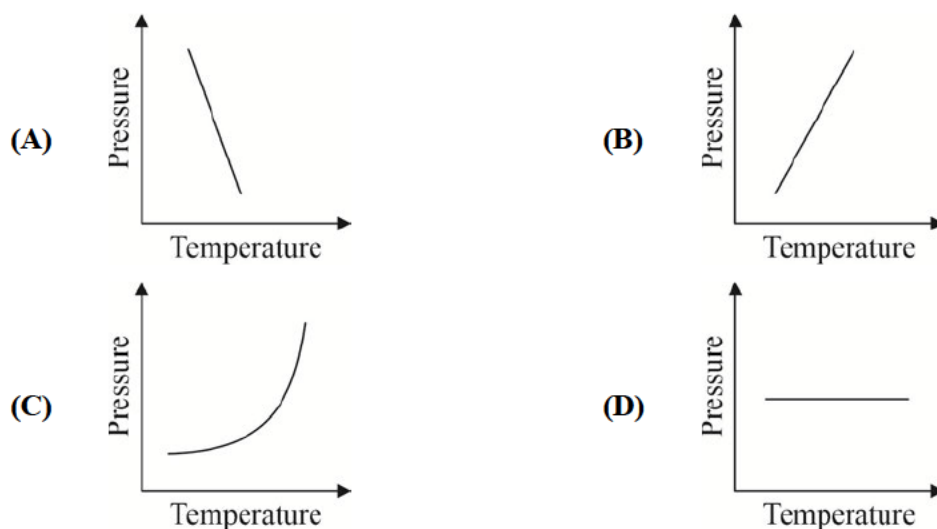
(C) $0.374 \text{ \AA}$

(D) $1.06 \text{ \AA}$

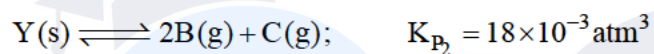
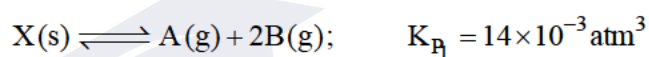
4. The Boyle temperature (T_B) is defined as the temperature at which the properties of a real gas coincide with those of an ideal gas in the low pressure limit. The graph that shows the pressure dependence of the compression factor (Z) for a real gas at T_B is :



5. A pure substance M has lesser density in solid state than in liquid state. The ΔS_{fusion} of M is $+35 \text{ JK}^{-1} \text{ mol}^{-1}$. The correct representative Pressure-Temperature diagram for the fusion of M is :



6. Two solid compounds X and Y dissociates at a certain temperature as follows :



The total pressure of gases over a mixture of X and Y is :

- (A) 4.5 atm (B) 0.45 atm (C) 0.6 atm (D) 0.2 atm

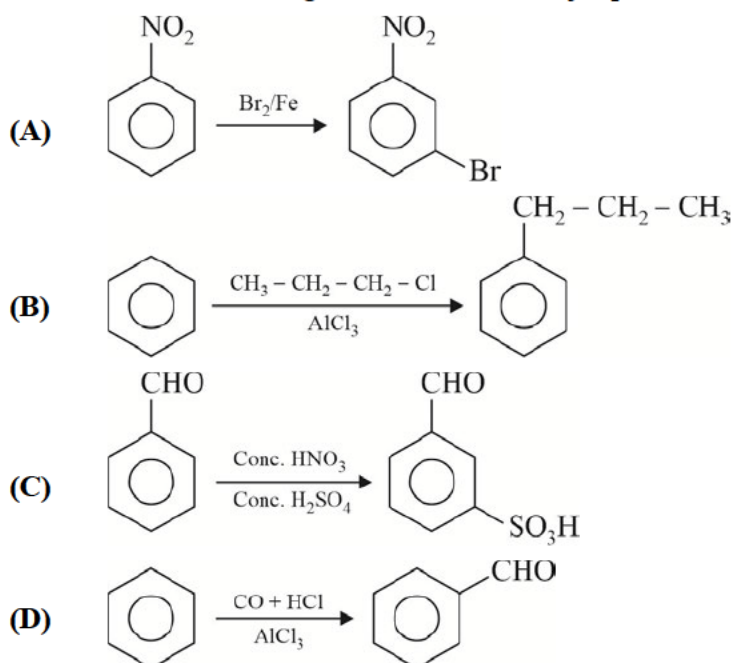
SPACE FOR ROUGH WORK

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of 06 Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

7. Which of the following is/are correct order ?
- (A) Atomic radius : $F < O < F^- < O^{2-}$
 (B) 2nd ionisation energy : $Be < B < F < Li$
 (C) Electron affinity : $I < Br < F < Cl$
 (D) Effective nuclear charge : $Al > Al^+ > Al^{2+} > Al^{3+}$
8. SbF_5 reacts with XeF_4 and XeF_6 to form ionic compounds $[XeF_3]^+[SbF_6]^-$ and $[XeF_5]^+[SbF_6]^-$ respectively then molecular shape of $[SbF_6]^-$ and $[XeF_3]^+$ ion respectively are incorrectly given in which options ?
- (A) Square pyramidal, T-shape (B) T-shape, Square pyramidal
 (C) Octahedral, T-shape (D) See-saw, octahedral
9. Select correct statement(s) :
- (A) Stability of peroxides and superoxides of alkali metals increases with increase in size of the cation
 (B) Milk of lime is a suspension of $Ca(OH)_2$ in water
 (C) Alkali metal hydrides are covalent and low melting solids
 (D) Mg and Ca both impart characteristic colour to the flame
10. Which of the following mixtures will function as buffer ?
- (A) $HCl + CH_3COONa$ (1 : 2 molar ratio) (B) $Na_2CO_3 + NaHCO_3$ (1 : 1 molar ratio)
 (C) $NaOH + HCOONa$ (1 : 1 molar ratio) (D) $NH_4Cl + (NH_4)_2SO_4$ (2 : 1 molar ratio)
11. In which of the following reactions correct major product is given ?



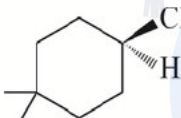
12. For the reaction $2\text{Ag}_2\text{O(s)} \longrightarrow 4\text{Ag(s)} + \text{O}_2\text{(g)}$, $\Delta H = 61.17 \text{ kJ/mol}$ and $\Delta S = 132 \text{ JK}^{-1}\text{mol}^{-1}$. Compute the temperature above which the given reaction will be spontaneous?
 (A) $T < 190.25^\circ\text{C}$ (B) $T < 463.4 \text{ K}$ (C) $T > 190.25^\circ\text{C}$ (D) $T > 463.4 \text{ K}$

SPACE FOR ROUGH WORK

SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

This section has 06 Questions. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to **TWO** decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25)

13. A 10 gm mixture of CuS and Cu_2S was treated with 400 mL of 0.4 M MnO_4^- in acid solution producing SO_2 , Cu^{2+} and Mn^{2+} . The SO_2 was boiled off and the excess of MnO_4^- was titrated with 200 mL of 1 M Fe^{2+} solution. What is the percentage of CuS in original mixture ?
 (Atomic mass of Cu is 64 amu, Atomic mass of S is 32 amu)
14. The number of stereoisomers possible for the following compound is :

15. Consider the structure of $\text{Al}_2(\text{CH}_3)_6$. This compound has Z_1 number of 2c-2e bonds and Z_2 number of 3c-2e bonds. What is sum of Z_1 and Z_2 ?
16. If number of π -bonds in H_3SiNCO is X and total number of coordinate bonds in $\text{H}_3\text{N} \cdot \text{BF}_3$, HNO_3 , CO , is Y then find $X + Y$?
17. $\text{CH}_3 - \text{CH}_3 \xrightarrow[\text{hv}]{\text{Br}_2} \text{(A)} \xrightarrow[\Delta]{\text{alc. KOH}} \text{(B)} \xrightarrow[\text{CCl}_4]{\text{Br}_2} \text{(C)} \xrightarrow[\Delta]{\text{alc. KOH}} \text{(D)} \xrightarrow[\Delta]{\text{NaNH}_2} \text{(E)} \xrightarrow{\text{NaNH}_2} \text{(F)} \xrightarrow{\text{CH}_3 - \text{Br}} \text{(G)} \xrightarrow{\text{NaNH}_2} \text{(H)} \xrightarrow{\text{CH}_3 - \text{Br}} \text{(I)}$
 What is the molar mass of organic product (I) ?
18. Stearic acid is a fatty acid, the part of fat that stores most of the energy. 1gm of stearic acid was burnt in bomb calorimeter. The bomb had a heat capacity of $650 \text{ J/gm} \cdot ^\circ\text{C}$. If the temperature of 500gm water (heat capacity = $4.20 \text{ J/gm} \cdot ^\circ\text{C}$) rose from 20°C to 40°C , then how much heat (in kJ) was released when the stearic acid was burnt ?

SPACE FOR ROUGH WORK

SECTION 1
SINGLE CORRECT ANSWERS TYPE

This section contains 06 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

1. For an increasing geometric sequence $a_1, a_2, a_3, \dots, a_n, \dots$ if $a_6 = 4a_4$ & $a_9 - a_7 = 192$ and $\sum_{i=4}^n a_i = 1016$, then n is:
(A) 8 (B) 9 (C) 10 (D) 11
2. Let z be a complex number such that $\left|5z + \frac{1}{z}\right| = 3$ and $\arg(z) = \theta$, then maximum value of $\cos(2\theta)$ is:
(A) $-\frac{1}{10}$ (B) $\frac{1}{10}$ (C) $\frac{1}{20}$ (D) $-\frac{1}{20}$
3. If the equations $x^3 + 10x^2 + ax + b = 0$ and $x^3 + 4x^2 + ax + c = 0$ have two roots in common, then the product of uncommon roots of two equations is:
(A) -30 (B) 30 (C) 40 (D) -40
4. Pair of tangents are drawn from $P(-1, 2)$ to $y^2 = 4x$ touching it at A, B , then area of triangle PAB (in sq. units) is equal to:
(A) $8\sqrt{2}$ (B) $4\sqrt{2}$ (C) $2\sqrt{2}$ (D) $\sqrt{2}$
5. Centres of two circles having radius 2 and 1 units are 5 units apart. The area of the quadrilateral formed by joining the points of contact of external tangents drawn to circles is equal to (in sq. units).
(A) $\frac{172\sqrt{6}}{25}$ (B) $\frac{96\sqrt{6}}{25}$ (C) $\frac{144\sqrt{6}}{25}$ (D) $\frac{72\sqrt{6}}{25}$
6. Let $f(x) = ax^4 + bx^2 + 3x + 7$ and $f(-4) = 2286$ and $f(4) = N$. The number of ways in which N can be resolved as a product of two divisors which are relatively prime:
(A) 15 (B) 16 (C) 17 (D) None of these

SPACE FOR ROUGH WORK

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of 06 Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

7. If $\sin(\sin x + \cos x) = \cos(\cos x - \sin x)$, then the value of $\sin x$ can be:
 (A) $\frac{\pi}{4}$ (B) $\frac{\sqrt{16-\pi^2}}{4}$ (C) $\frac{\pi}{8}$ (D) $-\frac{\pi}{4}$
8. Given z is a complex number satisfying $z^2 - z - |z|^2 + \frac{64}{|z|^5} = 0$ and $\operatorname{Re}(z) \neq \frac{1}{2}$ (where $\operatorname{Re}(z)$ denotes real part of (z)), then $|z|$ is less than:
 (A) 1 (B) 2 (C) 3 (D) 4
9. Point M moved on the circle $(x-4)^2 + (y-8)^2 = 20$. Then it broke away from it and moving along a tangent to the circle, cuts the x -axis at the point $(-2, 0)$. The co-ordinates of a point on the circle at which the moving point broke away is:
 (A) $\left(-\frac{3}{5}, \frac{46}{5}\right)$ (B) $\left(-\frac{2}{5}, \frac{44}{5}\right)$ (C) $(6, 4)$ (D) $(3, 5)$
10. A person buys twelve packet of VANISH detergent. Each packet contains one coupon, which bears one of the letters of the word VANISH. If he shows all the letters of the word VANISH, he gets one free packet. If he gets exactly one free packet, then the number of different possible combinations of the coupons is:
 (A) ${}^{18}C_6 - {}^{17}C_6$ (B) ${}^{11}C_5 - 1$ (C) ${}^{17}C_5$ (D) 461
11. If z is a complex number which simultaneously satisfies the equations $3|z-12|=5|z-8i|$ and $|z-4|=|z-8|$ then the $\operatorname{Im}(z)$ can be :
 (A) 15 (B) 16 (C) 17 (D) 8
12. If in a triangle ABC , $\cos A \cos B + \sin A \sin B \sin C = 1$, then the triangle is:
 (A) Isosceles (B) Right Angled
 (C) Equilateral (D) None of these

SPACE FOR ROUGH WORK

SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

This section has 06 Questions. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to **TWO** decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25)

13. If the relation between x and y such that the 20th arithmetic mean between x and $2y$ is same as the 20th arithmetic mean between $2x$ and y , (99 means being inserted in each case) is $y = kx$, then find k .
14. Number of terms free from radical sign in the expansion of $(1 + 3^{1/3} + 7^{1/7})^{10}$ is:
15. Let $P(x) = (m^2 + 4m + 5)x^2 - 4x + 7$, $m \in R$. If $3 \leq x \leq 5$ then find the minimum of minimum value of $P(x)$.
16. A line through the origin meets the circle $x^2 + y^2 = a^2$ at P & the hyperbola $x^2 - y^2 = a^2$ at Q . If the locus of the point of intersection of the tangent at P to the circle and the tangent at Q to the hyperbola is the curve $a^4(x^2 - a^2) + \lambda x^2 y^4 = 0$, then find the value of λ .
17. If $\sum_{n=1}^{2015} \tan\left(\frac{\theta}{2^n}\right) \sec\left(\frac{\theta}{2^{n-1}}\right) = \tan\left(\frac{\theta}{2^a}\right) - \tan\left(\frac{\theta}{2^b}\right)$ then $(b + a)$ equals:
18. If the radius of the circle touching the parabola $y^2 = 4x$ at an end of latus rectum and passing through the focus is $\sqrt{N}$, then the value of N is:

SPACE FOR ROUGH WORK

JEE ADVANCED - 2 | PAPER - 2

JEE 2022

Date 28th March, 2021	Maximum Marks 198	Duration 3 Hours
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PAPER SCHEME

- The question paper consists of 3 Subject (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each Part has **three** sections (Section 1, Section 2 & Section 3).
- Section 1** contains **SIX (06)** questions. The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 TO 9. **BOTH INCLUSIVE**.

Section 2 contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

Section 3 contains **6 Numerical Value Type Questions**. The answer to each of the question is a numerical value. For each question, enter the correct numerical value of the answer. **If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled. (Example: 6, 81, 1.50, 3.25)**
- For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code**, **Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Name of the Candidate (In CAPITALS) :

Roll Number :

OMR Bar Code Number :

Candidate's Signature : Invigilator's Signature

MARKING SCHEME

SECTION – 1 (Maximum Marks: 18)

- This section contains **SIX (06)** questions. The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 TO 9. **BOTH INCLUSIVE**.
For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	+3 If ONLY the correct integer is entered;
Zero Marks :	0 If the question is unanswered:
Negative Marks:	–1 In all other cases.

SECTION - 2 (Maximum Marks: 24)

- This section consists of **SIX (06)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+4 If only (all) the correct option(s) is(are) chosen
Partial Marks:	+3 If all the four options are correct but ONLY three options are chosen
Partial Marks:	+2 If three or more options are correct but ONLY two options are chosen and both of which are correct
Partial Marks:	+1 If two or more options are correct but ONLY one option is chosen, and it is a correct option
Zero Mark:	0 if none of the options is chosen (i.e. the question is unanswered)
Negative Marks:	–2 In all other cases.

SECTION – 3 (Maximum Marks: 24)

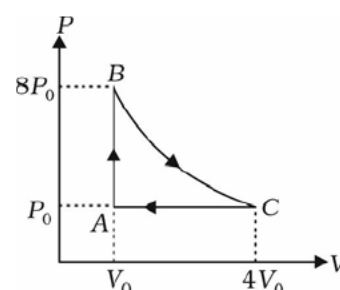
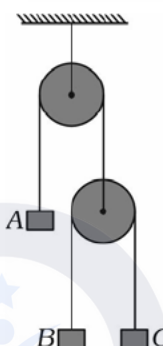
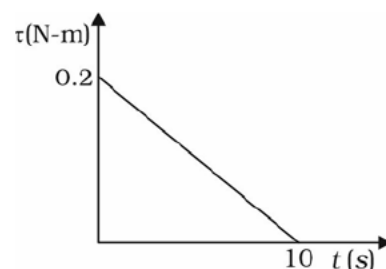
- This section has **SIX (06)** Questions. The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer. **If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled. (Example: 6, 81, 1.50, 3.25)**
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+4 If ONLY the correct numerical value is entered;
Zero Marks:	0 In all other cases.

SECTION 1
SINGLE DIGIT INTEGER

This section consists of **SIX (06)** questions. The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 TO 9. **BOTH INCLUSIVE.**

1. A solid cylinder of mass 12.5 kg and diameter 40 cm mounted to rotate about its central axis is initially at rest. A torque begins to act on the cylinder at $t = 0$. The variation with time of this torque is given in the graph. The angular speed of the cylinder at $t = 10$ s is _____ rad/s.
2. Three blocks A , B and C are arranged as shown with ideal pulleys and strings. The mass of the blocks B and C is 3 kg and 2 kg. For the block B to accelerate upwards, the mass of block A must be greater than _____ kg.
3. A wooden cube floats in water with $\frac{2}{5}$ fraction of its volume outside water. If a small metal block of mass 400 g is placed on the top surface of the cube, the cube floats with its upper surface coincident with the surface of the water. If the mass of the wooden cube is $100X$ g, the value of X is _____.
4. Two cars A and B move in the same direction at constant velocities 18 m/s and 12 m/s respectively, with A behind B . If the drivers of both cars use their horn (both emitting a frequency 406 Hz) at the same time, the beat frequency heard by the driver in A is _____ Hz.
(Speed of sound in air = 336 m/s)
5. Starting from rest at $t = 0$, a car accelerates at 6 m/s^2 for 5 seconds, and then decelerates at 2 m/s^2 until it comes to rest at $t = T$. If the distance travelled by the car between $t = 0$ and $t = T_0$ is equal to the distance travelled by it between $t = T_0$ and $t = T$, the value of T_0 (to the nearest integer in seconds) is _____.
6. A gas with $C_V = 2R$ is taken through the thermodynamic cycle $A \rightarrow B \rightarrow C \rightarrow A$ shown in the P-V diagram (where $B \rightarrow C$ is an adiabatic process). The net work done by the gas during the cycle is $X(P_0V_0)$. The value of X is _____.



SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of **SIX (06) Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

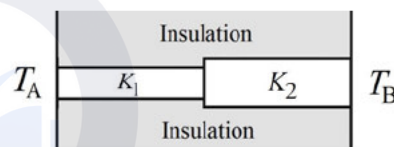
7. A block of mass 1 kg is suspended vertically using an ideal spring of spring constant 400 N/m. When the block is at rest in equilibrium, it is given a velocity $\frac{3}{2}$ m/s in the vertically downward direction.

Which of these options is/are correct? ($g = 10 \text{ m/s}^2$)

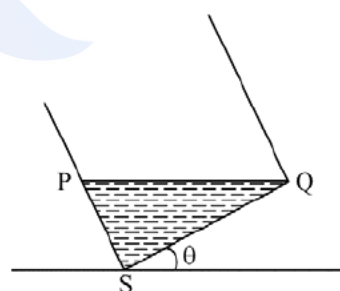
- (A) The time period of the resulting SHM is $\frac{\pi}{10}$ s
- (B) The amplitude of the resulting SHM is 7.5 cm
- (C) The block never reaches any point higher than its initial position
- (D) The block never achieves a speed greater than its initial speed

8. Two cylindrical metal rods, both of length 16 cm, area of cross-section 10 cm^2 and 20 cm^2 , and thermal conductivity $K_1 = 400 \text{ W/mK}$ and $K_2 = 160 \text{ W/mK}$ are placed end to end between two reservoirs at temperature $T_A = 200^\circ\text{C}$ and $T_B = 20^\circ\text{C}$ as shown. Which of these options is/are correct?

- (A) The rate of heat flow through the rods is 200 W
- (B) The rate of heat flow through the rods is 240 W
- (C) The temperature gradient in the first rod is 5.0°C/cm
- (D) The temperature gradient in the second rod is 7.5°C/cm



9. A liquid of density ρ is contained in a vessel which is held such that its base is inclined at an angle θ with the horizontal, as shown. The vertex Q of the vessel lies on the surface of the liquid. The vessel is cuboidal in shape with its base being a square of side length L . Let P_0 denote the atmospheric pressure. Let the force due to liquid pressure on the base of the vessel be $\vec{F}_B$ and let the force due to liquid pressure on the wall of the vessel which is perpendicular to the plane of the paper (i.e. the wall PS) be $\vec{F}_S$. Which of these options is/are correct?



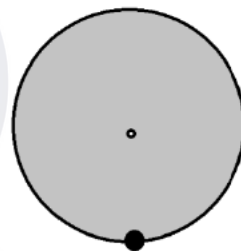
- (A) The horizontal component of $\vec{F}_B$ is $\left(P_0 L^2 \sin \theta + \frac{1}{2} \rho g L^3 \sin^2 \theta \right)$
- (B) The horizontal component of $\vec{F}_S$ is $\left(P_0 L^2 \sin \theta + \frac{1}{2} \rho g L^3 \sin^2 \theta \right)$
- (C) The vertical component of $\vec{F}_B$ is $\left(P_0 L^2 \cos \theta + \frac{1}{2} \rho g L^3 \sin \theta \cos \theta \right)$
- (D) The vertical component of $\vec{F}_S$ is $\left(P_0 L^2 \sin \theta \cos \theta + \frac{1}{2} \rho g L^3 \sin^2 \theta \cos \theta \right)$

10. A thin uniform rod of length L and mass m is pivoted at a point at a distance $\frac{L}{3}$ from one of its ends such that it can rotate freely in the vertical plane. The rod is released from rest in the horizontal position as shown. Which of these options is/are correct?



- (A) The initial acceleration of the centre of mass of the rod is $\frac{3g}{4}$
- (B) The force applied by the pivot on the rod just after it is released is $\frac{3mg}{4}$
- (C) As it rotates, the maximum angular velocity the rod attains is $\sqrt{\frac{3g}{L}}$
- (D) At the instant the angular velocity of the rod is maximum, the acceleration of its centre of mass is $\frac{g}{2}$
11. A small particle of mass m is fixed on the rim of a thin uniform disc of mass $2m$ and radius R . The disc is now pivoted at its centre such that it can rotate freely about an axis perpendicular to the plane of the disc. Starting from the equilibrium position shown, the body is rotated by a small angle θ_M and released. Subsequently:

- (A) The body executes SHM of frequency $\frac{1}{2\pi} \left(\frac{g}{2R} \right)^{1/2}$
- (B) The body executes SHM of frequency $\frac{1}{2\pi} \left(\frac{2g}{3R} \right)^{1/2}$
- (C) The maximum kinetic energy of the body is $\frac{3}{2} mgR\theta_M^2$
- (D) The maximum kinetic energy of the body is $\frac{1}{2} mgR\theta_M^2$



12. A wire of length 1.2 m and mass per unit length 0.1 kg/m is stretched horizontally and clamped at both its ends. A transverse stationary wave is set up in the wire. Taking the X -axis along the wire and the origin at one of its ends, the equation of the stationary wave is:

$$y = y_m \sin\left(\frac{5\pi x}{2}\right) \cos(600\pi t)$$

Here, y represents the displacement of a particle on the wire along the Y -direction, y_m is a constant, and all quantities are in SI units. Which of these options is/are correct?

- (A) The wavelength is 0.8 m
- (B) $x = 0.2$ m is an antinode
- (C) The fundamental frequency of the wire is 100 Hz
- (D) The distance between two adjacent nodes on the wire is 0.4 m

SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

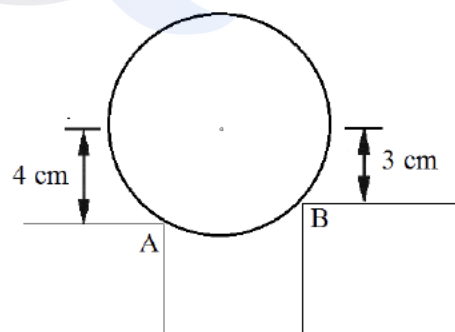
This section has SIX (06) Questions. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to **TWO** decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25)

13. A particle is moving in the X - Y plane. Its position as a function of time is given by: $\vec{r} = \cos(3t)\hat{i} + 2\sin(3t)\hat{j}$. Let $t = t_0$ be the first instant after $t = 0$ when the force acting on the particle is perpendicular to its velocity. The distance of the particle from the origin at $t = t_0$ is _____.

14. A cylindrical beaker is filled with mercury to a height 10 cm at 20°C . When it is heated to 80°C , the height of the mercury column in the beaker increases by _____ mm.
(Assume that the beaker is sufficiently tall so that no mercury spills out; Coefficient of volume thermal expansion of glass $= 2.5 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$, coefficient of volume thermal expansion of mercury $= 1.75 \times 10^{-4} \text{ }^\circ\text{C}^{-1}$) [Use the fact that for $a \ll 1$ and $b \ll 1$, $\frac{1}{1+a} \approx 1-a$ and $(1+a)(1+b) \approx 1+a+b$]

15. Let g denote the acceleration due to gravity at the surface of the earth and let v_e denote the escape velocity from the surface of the earth. A particle is projected vertically upwards from the surface of the earth with velocity v . At the instant its velocity becomes zero, its acceleration is $\frac{9g}{16}$. The ratio $\frac{v}{v_e}$ is equal to _____.

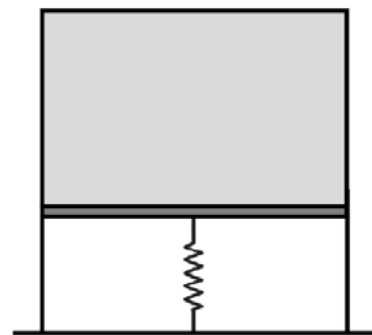
16. A sphere of radius 5 cm and mass 4 kg rests on two point supports as shown, such that the points A, B and the centre of the sphere are in the same vertical plane. Friction is absent. The height difference between the supports and the centre of the sphere is shown in the figure. The force acting on the sphere from the support A is _____ N. ($g = 10 \text{ m/s}^2$)



17. A steel wire of length 1 m is clamped at both ends and put under tension such that its length increases by 0.4 mm. Then, the minimum frequency (to the nearest integer) of transverse standing waves that can be set up on the wire is _____ Hz.

(Density of steel $= 8 \times 10^3 \text{ kg/m}^3$, Young's modulus of steel $= 2 \times 10^{11} \text{ N/m}^2$)

-
18. A cylindrical vessel with a massless movable piston of area of cross-section 0.1 m^2 contains an ideal gas. The piston is connected to an ideal spring of spring constant 10^6 N/m . Initially, the spring is compressed by 2 cm . Now, heat is supplied to the vessel until the compression in the spring has increased to 5 cm . The work done by the gas during the process is _____ kJ.
(Atmospheric pressure $= 10^5 \text{ Pa}$)



SPACE FOR ROUGH WORK



SECTION 1

SINGLE DIGIT INTEGER

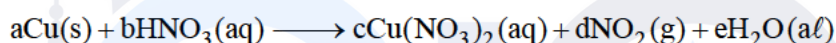
This section consists of **SIX (06)** questions. The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 TO 9. **BOTH INCLUSIVE.**

- 0.0005 moles of metal bromide were dissolved in water and 60.0ml of 0.025M silver nitrate solution was required to complete precipitation of silver bromide. The oxidation state of the metal ion in the metal bromide is :
- In an acidic solution I^- changes to I_2 . How many grams of I_2 is produced if, in the same process, 1.5×10^{22} electrons are used to reduce H_3AsO_4 to H_3AsO_3 ?

(Given: $N_A = 6 \times 10^{23}$, atomic mass of I = 127 g/mol)

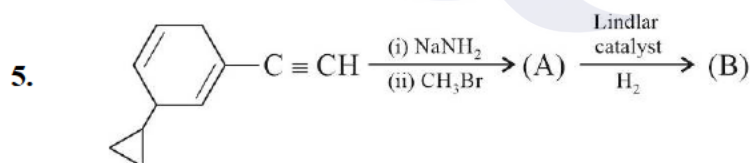
Report your answer after rounding off to the nearest integer.

- Metallic copper reacts with conc. nitric acid and produces $\text{Cu}(\text{NO}_3)_2$, NO_2 and H_2O . The variables given below as a, b, c, d and e represent the stoichiometric coefficients.



Find $\frac{a+b+c+d+e}{5}$:

- An element 'X' has its electronic configuration of K-shell is $(n-5)s^2$ and it has total number of electrons in its outermost, penultimate and antepenultimate shell are 2, 8, 28 respectively then find out total number of unpaired electrons in element 'X' in their ground state.



Degree of unsaturation (hydrogen deficiency index) in organic product (B) is:

- Total number of constitutional isomers possible for trimethyl cyclohexane is _____.

SPACE FOR ROUGH WORK

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of SIX (06) Multiple Correct Answers Type Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

7. Two identical containers, each of volume V_0 are joined by a small pipe of negligible volume. The containers contain identical gases at temperature T_0 and pressure P_0 . One container is heated to temperature $3T_0$ while maintaining the other at the same temperature T_0 . The common pressure of the gas is P and n is the number of moles of gas in container at temperature $3T_0$ then:

(A) $P = \frac{4P_0}{3}$ (B) $n = \frac{2P_0 V_0}{3RT_0}$ (C) $n = \frac{P_0 V_0}{2RT_0}$ (D) $P = \frac{3}{2}P_0$

8. For the reaction, $2\text{NO}_{(g)} + \text{O}_{2(g)} \longrightarrow 2\text{NO}_{2(g)}$; $\Delta H = -35\text{kcal}$ at 300K . If 6 moles of NO reacts with 3 moles of O_2 at constant pressure of 1 atm and temperature 300K to form NO_2 then the correct statement is/are: [Given $R = 2 \text{ cal mol}^{-1} \text{ K}^{-1}$]

- (A) The amount of heat released by reaction is 35 kcal
 (B) The internal energy of system decreased by 103.2 kcal
 (C) The magnitude of work done by system is 1.8 kcal
 (D) The amount of heat released by reaction is 105 kcal

9. In which of the following carbocation/s rearrangement takes place?



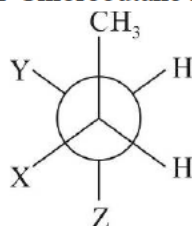
10. In which of the following solutions, the degree of dissociation of H_2O is less than $1.8 \times 10^{-7}\%$ at 25°C ?

- (A) 10^{-6} M HCl (B) 10^{-7} M NaOH
 (C) $10^{-2} \text{ M NH}_4\text{OH}$ (D) $10^{-6} \text{ M H}_2\text{SO}_3$

11. Which of the following statement(s) is/are correct?

- (A) The second ionization enthalpy of O is greater than that of F
 (B) The third ionization enthalpy of P is greater than that of Al
 (C) The first ionization enthalpy of Al is slightly greater than that of Ga
 (D) The second ionization enthalpy of Cu is greater than that of Zn

12. If the newman projection formula for 2-Chlorobutane is given as:



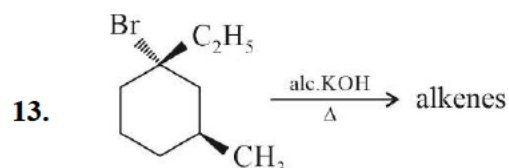
Which of the following is/are incorrect:

- (A) X is Cl and Y & Z are CH_3 & H (B) X is CH_3 and Y & Z are H & Cl
 (C) X is H and Y & Z are H & CH_2Cl (D) X is CH_3 and Y & Z are CH_3 & Cl

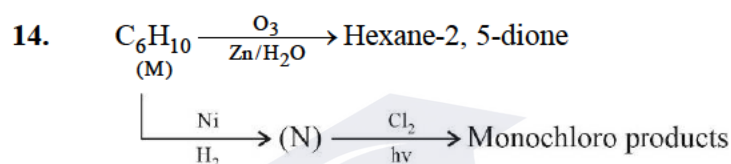
SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

This section has SIX (06) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled. (Example: 6, 81, 1.50, 3.25)



Sum of number of hyper conjugable α - H atoms in all alkenes formed in above reaction will be:



The number of monochloro products (excluding stereoisomers) obtained by monochlorination of N is/are :

15. Consider the following species
 H_2O , $\text{O}(\text{CH}_3)_2$, $\text{N}(\text{SiH}_3)_3$, CO , CH_3NCS , BF_3
Find the value of '10ab' ?
a = number of species having $p\pi - d\pi$ bond
b = total number of species having $p\pi - p\pi$ bond

16. Number of sp^3 hybridized boron atoms in borax is:
17. If average oxidation state of all carbon atoms in C_3O_2 is x and if number of oxygen atoms in neutral oxide of carbon is y then find $(30x + y)$?
18. In a sample of H-atom containing 1 mole H-atoms, electrons in 30% of H-atoms are in 1st excited state and remaining are in 2nd excited state and ground state. If the total energy emitted when all electrons return to ground state is 642.24 kJ. Then find % of electrons in 2nd excited state.
[Energy level in H-atom = $E_1 = -13.6\text{eV}$, $E_2 = -3.4\text{eV}$, $E_3 = -1.5\text{eV}$, , $1\text{eV/species} = 96\text{ kJ/mole}$]

SPACE FOR ROUGH WORK

SECTION 1

SINGLE DIGIT INTEGER

This section consists of SIX (06) questions. The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 TO 9. BOTH INCLUSIVE.

1. From point P on hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ in first quadrant, line parallel to x-axis & y-axis are drawn cutting hyperbola at Q & R respectively. Let A be the vertex of hyperbola in 1st quadrant. If Area $(\Delta APQ) = 2 \text{ Area}(\Delta APR)$, then eccentric angle of P is $\frac{a\pi}{b}$ (where a & b are relatively prime integers).
The value of $a + b$ is _____.
2. Let C be the centre of ellipse $\frac{x^2}{16} + \frac{y^2}{4} = 1$. Let P be any point on the ellipse such that angle between tangent to ellipse at P and CP is minimum. If length of CP is $\sqrt{N}$, then $\frac{N}{2}$ is _____.
3. If z_1, z_2 are complex numbers, then the maximum value of $\frac{z_1\bar{z}_2 + \bar{z}_1z_2 + z_1z_2 + \bar{z}_1\bar{z}_2}{|z_1z_2|}$ is equal to _____.
4. If 8 harmonic means are inserted between two numbers a and b ($a < b$) such that arithmetic mean of a and b is $\frac{5}{4}$ times equal to geometric mean of a and b , then $\left(\frac{H_8 - a}{b - H_8}\right)$ is equal to _____.
5. Find the largest integer value of x satisfying the inequality $\log_{0.09}(x^2 + 2x) \geq \log_{0.3}\sqrt{x+2}$.
6. If N denotes the number of non-empty subsets of $\{1, 2, 3, \dots, 12\}$ having property that the sum of largest element and smallest element is 13, then number of divisors of N divisible by 5 is:

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SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This section consists of SIX (06) Multiple Correct Answers Type Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

7. Number of ways in which A A B B B C can be placed in the squares of the figure as shown so that no row remains empty, is:



- (A) 81 (B) 4860 (C) $81\left(\frac{6!}{2!3!}\right)$ (D) 1620
8. Let ΔPQR be formed by the common tangents to the circles $x^2 + y^2 + 6x = 0$ and $x^2 + y^2 - 2x = 0$, then which of the following is (are) true?
 (A) Centroid of ΔPQR is (1, 0)
 (B) Radius of circle inscribed in ΔPQR is 1
 (C) Area of ΔPQR is $3\sqrt{3}$
 (D) The y-intercept of common tangent having negative slope is 3
9. If a, b, c are in H.P., then which of the following is true?
 (A) $\frac{a}{1-2a}, \frac{b}{1-2b}, \frac{c}{1-2c}$ are in H.P. (B) $\ln\left(a - \frac{b}{2}\right), \ln \frac{b}{2}, \ln\left(c - \frac{b}{2}\right)$ are in H.P.
 (C) $c - \frac{b}{2}, \frac{b}{2}, a - \frac{b}{2}$ are in G.P. (D) $e^{1/a}, e^{1/b}, e^{1/c}$ are in G.P.
10. If z_1 & $\bar{z}_1$ represent adjacent vertices of a regular polygon of n sides with centre at the origin & if $\frac{\text{Im } z_1}{\text{Re } z_1} = \sqrt{2} - 1$, then the value of n is a multiple of:
 (A) 8 (B) 12 (C) 16 (D) 4
11. If in the expansion of $(1+x)^m(1-x)^n$, the coefficients of x and x^2 are 3 and -6 respectively, then:
 (A) $n = 6$ (B) $n = 9$ (C) $m = 12$ (D) $m = 24$
12. If roots of the quadratic equation $(x+a)(x+1991)+1=0$ are integer, then 'a' is equal to (a is integer):
 (A) 1989 (B) 1991 (C) 1993 (D) 1995

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SECTION 3

NUMERICAL VALUE TYPE QUESTIONS

This section has SIX (06) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled. (Example: 6, 81, 1.50, 3.25)

13. Let C be the set of 6 consonants $\{b, c, d, f, g, h\}$ and V be a set of 5 vowels $\{a, e, i, o, u\}$ and W be the set of seven letter words that can be formed with these 11 letters using both the following rules:
(a) The vowels and consonants in the word must alternate.
(b) No letter can be used more than once in a single word.
If the number of words in the set W are K then find $K/7$.
14. The vertices of a triangle OBC are $O(0, 0)$, $B(-3, -1)$, $C(-1, -3)$. Equation of line parallel to BC whose equation is $ax + by + 2 = 0$ & intersecting the sides OB & OC whose perpendicular distance from the point $(0, 0)$ is $\frac{1}{\sqrt{2}}$, then the value of $\frac{a^4 + b^4}{4}$ is _____.
15. If α and β are roots of equation $\frac{27}{4} \sin\left(\frac{\theta}{9}\right) = \sin^3 \theta + 3 \sin^3\left(\frac{\theta}{3}\right) + 9 \sin^3\left(\frac{\theta}{9}\right) + \frac{1}{4\sqrt{2}}$ for $0 < \theta < \frac{\pi}{2}$, then $\tan \alpha + \tan \beta$ is equal to _____.
16. Find the coefficient of x^{18} in the polynomial
$$f(x) = (1+x)^{20} + x(1+x)^{19} + x^2(1+x)^{18} + \dots + x^{18}(1+x)^2.$$
17. Consider a straight line $\frac{x}{a} + \frac{y}{b} = 1$, such that it cuts the asymptotes of hyperbola $xy = 1$ in points A and B & the hyperbola itself in P and Q , then $\frac{AP}{BQ} = 5\lambda$, then λ is _____.
18. Let ' p ' be an integer for which both roots of the quadratic equation $x^2 + 2(p-3)x + 9 = 0$ lies in $(-6, 1)$. If $2, g_1, g_2, \dots, g_{19}, g_{20}, p$ are in G.P., then find the value of $g_4 g_{17}$.